PROCEEDINGS

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53rd Internationales Wissenschaftliches Kolloquium
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H. Witte / M. S. Fischer

InspiRat – Technical Biology: How to Analyse Vertebrate Climbing

MOTIVATION

InspiRat is the acronym for a project aiming at the realization of small biologically inspired climbing machines. It is realized by partner groups from Technische Universität Ilmenau, Friedrich-Schiller-Universität Jena and Max-Planck-Institute Stuttgart in cooperation with the Ilmenau company TETRA.

Understanding of principles of climbing of vertebrates as paragons for climbing machines has to be based on knowledge of their climbing mechanics and control. Since climbing is a mechanical process, descriptors have to be taken from mechanics: motion parameters (kinematics), forces and moments/torques (dynamics). How to measure mechanical properties like geometry and mass distributions (morphometry) and how to perform modelization will be reported elsewhere.

NATURAL PARAGONS

For the biological inspiration of machine construction the spectrum of species is unlimited and covers vertebrates as well as invertebrates. Since the prospective mass of such a machine is in the range of 1 kg, based on simple hypotheses, experimental studies are performed on small vertebrates like chameleons or rats (fig. 1).

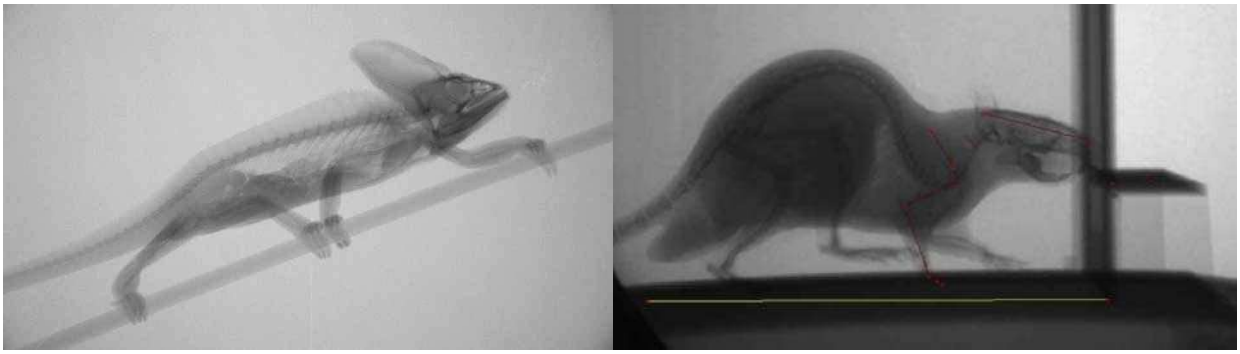

Fig. 1: Isolated pictures of cineradiographies. Left: chameleon. Right: rat.

KINEMATICS

Kinematical analyses are realized via cineradiography (cf. fig. 1). The biplanar system is based on the high-end X- ray system Neurostar® from Siemens®. For very high frame rates, the use of X-ray image intensifiers in combination with TV- cameras was required. Two 16” image intensifiers are available. At full format of 16” the resolution is better than 1.3 LP/mm. For the X-ray channel we selected a first class high speed camera SPEEDCAM® visario g2 from Weinberger-Vision Company in Erlangen (Germany). With some overframing we can obtain 2.000 f/s at 1.024 times 768 pixels.

DYNAMICS

The interactions of animals with substrates are measured synchronously to the cineradiography by self-constructed sensor setups, including commercial and self-constructed sensors (fig. 2).

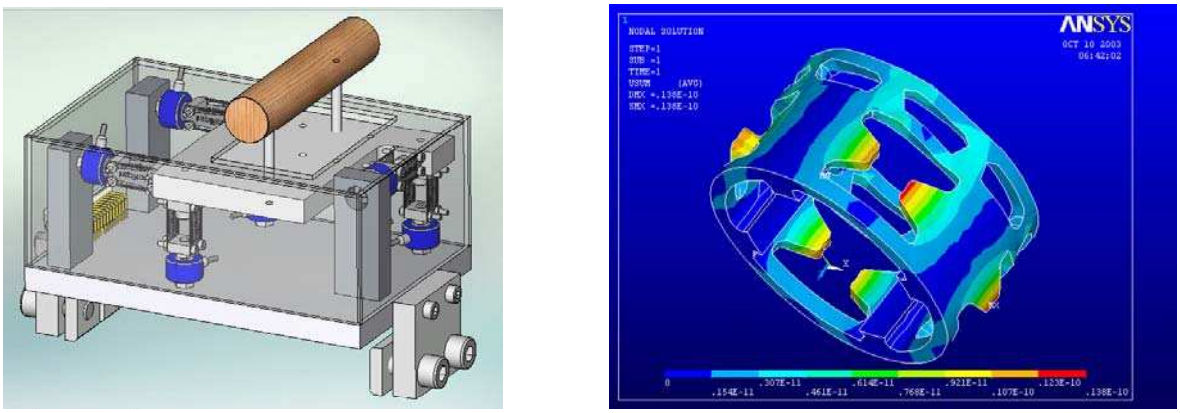

Fig. 2: Sensor setup to measure forces and torques on substrate during climbing.
Left: sensor location for external measurement. Right: sensor to be integrated in substrate.

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